TECHNICAL SPECIFICATION FOR COYOTE CONDUCTOR FOR DISTRIBUTION LINES

1.0 **Scope**:

1.1 This specification provides for design, manufacture, engineering, inspection and testing before dispatch, packing and delivery F.O.R. (destination) of COYOTE aluminium conductors steel reinforced (ACSR) for overhead distribution purposes specified herein.

1.2 The conductor shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or material, which in his judgment is not in full accordance therewith.

2.0 **Standards**:

2.1 Except as modified in this specification they shall conform to the following Indian Standards, which shall mean latest revisions, amendments thereof. Equivalent International and Internationally recognized standard to which some of these standards generally correspond are also listed below:

Sl. No.	Indian Standards	Title	International Standards
1	IS: 209	Specification for zinc	**BS: 3436**
2	IS: 398 Part-2 :2025 (Ammd if any)	Specification for aluminium conductors for overhead transmission purpose	**IEC: 209** **BS: 215** (Part-II)
3	IS: 1778	Reels and Drums for Bare Conductors	**BS: 1559**
4	IS: 1521	Method of Tensile Testing of steel wire	**ISO/R89**
5	IS: 2629	Recommended practice for Hot Dip Galvanizing of Iron and Steel	
6	IS: 2633	Method of Testing Uniformity of coating of zinc coated Articles	
7	IS: 4826	Galvanized coating on round steel wire	**ASTM A-472 729**
8	IS: 6745	Method of Determination of weight of zinc coating of zinc coated Iron and Steel Articles.	**BS: 443**
9	IS: 1841	EC grade Aluminium rod produced by rolling (second Revision)	
10	IS: 5484	EC grade Aluminium rod produced by continuous casting and rolling (first revision)	
11	IS: 6754	Methods of determination of weight of zinc coating of zinc coated Iron and steel Articles.	
12	C-49 CSA	Specification for Drake ACSR	

The Aluminium Coyote conductor required for overhead transmission purpose aluminium, steel, galvanizing, chemical composition, stranding, testing etc., shall comply as per IS-398(Part-2):2025 and its amendments if any thereon.

2.2 The standards mentioned above are available from:

Reference Abbreviation	**Name and Address**
BS	British Standards, British Standards Institution, 101, Pentonvile Road, N-19-ND – UK
IEC/CISPR	International Electro-technical Commission, Bureau Central de la Commission, Electro Technique International, 1 Rue de verembe, Geneva, SWITZERLAND
BIS	Bureau of Indian Standards, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi-110 001 INDIA
ISO	International Organization for Standardization, Danish Board of Standardization, Danish Standardizing Sraat, Aurehoegvej-12, DK-2900, Heelprup, DENMARK
NEMA	National Electric Manufacture Associate, 115, East 44th Street, New York NY 10017 U.S.A
CSA	Canadian Standards Assn.

However, in an event where the Bidder offers ACSR conductor conforming to standards equivalent to or better than the above, the salient points of comparison between the standards adopted and the standards quoted herein shall be detailed in relevant schedule. Two copies of authenticated English version of such standards shall be furnished along with the offer.

3.0 **Principal Parameters**:

The details of conductor are tabulated below:

Stranding and wire diameter	**26/2.54 mm Aluminium 7/1.91 mm Steel (Coyote)**
a) Number of Strands Steel Centre. I Steel Layer I Al. Layer II Al. Layer	 1 6 10 16
Sectional area of aluminium (Sq.mm)	131.7
b) Total sectional area (Sq.mm)	151.8
c) Overall diameter (mm)(Approx)	15.89
d) Approximate weight (kg/km)	521
e) Calculated D.C resistance at 20^0C (ohm/km)	0.2192
f) Breaking Load (Min) KN	45.65
g) Modulus of Elasticity (Kgs/Sq.cm x 10^6)	0.773
h) Co-efficient of Linear expansion / °C	18.99 x 10^{-6}

3.1 The details of Aluminium strand are as follows:

a) Nominal Dia of Aluminium wire	2.54 mm
b) Minimum Dia of Aluminium wire	2.52mm
c) Maximum Dia of Aluminium wire	2.56mm
d) Minimum breaking load of strand before stranding (KN)	0.86KN (88kg)
e) Minimum breaking load of strand after stranding (KN)	0.82KN (84kg)
f) Maximum DC resistance of strand at 20^0C (ohm/km)	5.667

3.2 The details of steel strand are as follows:

i. Nominal Dia of Steel wire	1.91 mm
ii. Minimum Dia of Steel wire	1.87 mm
iii. Maximum Dia of Steel wire	1.95 mm
iv. C/S Area of Nominal Dia of wire	2.865 mm
v. Mass of Steel wire	22.35 kg/kM
vi. Minimum breaking load of strand before stranding (KN)	3.99KN (406kg)
vii. Minimum breaking load of strand after stranding (KN)	3.79KN (386kg)
viii. Minimum weight of zinc coating (gm/sq.m	210

4.0 **General Technical Requirement**:

4.1 The conductor shall be suitable for satisfactory operation under the tropical climatic conditions given in the project synopsis.

4.2 **Physical constants of materials**:

4.2.1 Physical constants for Hard-drawn Aluminium.

4.2.2 Resistivity: The resistivity of aluminium depends upon its purity and its physical condition. For the purpose of this specification the maximum value permitted is 0.028264 Ohm.sq.mm/Mtr 20^0C, and this value has been used for calculation of the maximum permissible value of resistance.

NOTE: It is not intended to check the resistivity from the measured values of resistance.

4.2.3 Density: At a temperature of 20^0C the density of hard drawn aluminium has been taken as 2.703 g/cubic cm.

4.2.4 Constant-Mass Temperature Co-efficient of Resistance: At a temperature of 20^0C the constant-mass temperature co-efficient of resistance of hard drawn aluminium measured between two potential points rigidly fixed to the wire, the metal being allowed to expand freely, has been taken as 0.00403 per °C (degree Celsius).

4.2.5 Co-efficient of linear expansion: The coefficient of linear expansion for hard drawn aluminium at 0^0C has been taken as 23.0 x $10^{-6}/^0$C. This value holds good for all practical purposes over the range of temperature from 0^0C to highest safe operating temperature.

4.3 **Physical constant for Galvanized steel wires**:

4.3.1 Density: At a temperature 20^0C, the density of galvanized steel wire is to be taken as 7.80 g/cm^3.

4.3.2 Co-efficient of Linear Expansion: In order to obtain uniformity in calculations a value of 11.5 x $10^{-6}/^0$C may be taken as the value for the co-efficient of Linear Expansion of galvanized steel wires used for the cores of steel-reinforced Aluminium conductors.

4.4 **Materials**:

4.4.1 The conductors shall be manufactured from EC grade aluminium rod suitably hard-drawn on wire drawing machines. The aluminium rods used shall comply with IS: 1841 and IS: 5484. The mechanical and electrical properties of aluminium wire shall comply with the requirements given in relevant standard.

4.4.2 Galvanized steel wire shall be drawn from high carbon steel rods produced by either acidic or basic open-hearth process, electric furnace process or basic oxygen process. The mechanical and electrical properties of wire shall comply with the requirements given in relevant standard. The chemical composition of high carbon steel wire is given below for guidance only.

Element	**Percentage Composition**
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorous	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.3

4.4.3 The zinc used for galvanizing shall be electrolytic high-grade zinc not less than 99.95% purity. It shall conform to and satisfy all the requirements of IS: 209 Galvanizing may be done by hot process. Natural grease (Non-acidic & Non alkaline Petroleum jelly/mineral oil based "neutral" grease) may be applied between the layers of wires.

NOTE: Lithium soap grease corresponding to Grade-II of IS: 7623 (Specification for lithium soap greases) is suitable for such application.

4.5 **Freedom from Defects**:

4.5.1 The wires shall be smooth and free from all imperfections such as spills, splits, slag inclusion, die marks, scratches, pittings, blow-holes, projections, looseness, overlapping of strands, chipping of aluminium layers etc and all such other defects, which may hamper the and mechanical/ electrical properties of the conductor. Special care should be taken to keep away dirt, grit etc during stranding.

4.6 **Wire sizes**:

4.6.1 **Nominal size:**

The aluminium and galvanized steel wires for the stranded conductor covered by this standard shall have diameters specified in clause 3.1. The diameter of the steel wires shall be measured over the zinc coating.

4.6.2 **Tolerances on normal size**:

4.6.2.1 Aluminium wires: A tolerance of $\pm$0.02mm is permitted on the wire Nominal diameter

4.6.2.2 Galvanized steel earth wire: A tolerance of $\pm$ 2% is permitted on the nominal diameter.

4.6.2.3 Outer diameter of conductor: A tolerance of ±1% is permitted on the conductor

NOTE: In order to maintain the circularity of the wires the tolerance allowed in 4.6.2.1 and 4.6.2.2 shall apply to both the measurements at right angles taken at the same cross-section as per Clause 2.2 of IS:398 (Part-II) (Second Revision with Amendments 1 to 30).

4.7 **Joints in Wires**:

4.7.1 Aluminium Wires: No joints shall be permitted in the aluminium wires in the outermost layer of the ACSR Conductor. Joints in the inner layers are permitted, in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15 meter apart in the complete stranded conductor. Such joints shall be made by cold pressure butt-welding.

NOTE: Joints are not permitted in the outermost layer of the conductor in order to ensure a smooth conductor finish and reduce radio interference levels and corona losses on the extra high voltage lines.

4.7.2 Galvanized steel wires: There shall be no joints except those in the base rod or wire before final drawing, in steel wires forming the core of the steel-reinforced aluminium conductor.

NOTE: Joints are not permitted in the steel wires after final drawing in order to avoid reduction in the breaking strength of the conductor that may occur as a result of failure of the joints.

4.8 **Stranding**:

4.8.1 The wires used in the construction of galvanised steel reinforced aluminium conductor shall before stranding, satisfy all the relevant requirements of this specification.

4.8.2 The lay ratio of the different layers shall be within the limits given in the following tables:

LAY RATIO OF ALUMINIUM CONDUCTORS, GALVANISED STEEL-REINFORCED (Coyote)

COYOTE ACSR	Maximum	Minimum
a) Steel Wire	28	13
b) Aluminium		
i. 10 Wire layer	16	10
ii. 16 Wire layer	14	10

NOTE: For the purpose of calculation, the mean lay ratio shall be taken as the arithmetic mean of the relevant minimum and maximum values given in this table.

4.8.3 In all constructions, the successive layers shall have opposite directions of lay, the outermost layer being right-handed. The wires in each layer shall be evenly and closely stranded.

4.8.4 In conductors having multiple layers of aluminium wires, the lay ratio of any aluminium layer shall not be greater than the lay ratio of the aluminium layer immediately beneath it.

4.9 **Standard Length**:

4.9.1 The standard length of the Conductor shall be in Standard length of 1500 meters. However, the bidder may offer a higher standard length. A tolerance of ±5% on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths.

4.9.2 Random lengths will be accepted provided no length is less than 70% of the standard length specified and the total quantity of such random lengths shall not be more than 5% of the total quantity ordered.

4.9.3 Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars. This is required for special stretches like river crossing etc. The purchaser reserves the right to place orders for the above length on to the extent of 10% of the total ordered quantity. The same terms and conditions applicable for the standard lengths during the pendency of the contract.

5.0 **TESTS**:

5.1 The type, acceptance, routine tests and tests during manufacture shall be carried out on the conductor. For the purposes of this clause:

5.1.1 Type tests shall mean those tests, as per IS, which are to be carried out to prove the design, process of manufacture and general conformity of the material to this specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests in the offer.

5.1.2 Acceptance Tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.

5.1.3 Routine Tests shall mean those tests, which are to be carried out on each strand/spool/length of the conductor to check requirements, which are likely to vary during production.

5.1.4 Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture by the supplier to ensure the desired quality of the end product to be supplied by him.

5.1.5 The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the supplier and the purchaser as per relevant clause of General Conditions of Contract.

5.1.6 The standards and norms to which these tests will be carried out are listed against them. Where a particular test is a specific requirement of this specification, the norms and procedures of the test shall be as specified in Annexure-II or as mutually agreed to between the supplier and the purchaser in the Quality Assurance Programme.

5.1.7 For all type and acceptance tests, the acceptance values shall be the values guaranteed by the bidder in the “Guaranteed Technical Particulars”, Part-II of his proposal or the acceptance value specified in this specification, whichever is more stringent for that particular test.

5.2 Type tests:

The following type tests shall be conducted before manufacturing/as per BESCOM requirement. The type test conducted at CPRI/ERDA/Accredited Govt. Labs recognised by BIS as per Clause-(13) of IS:398 (Part-2)-2025 with its latest amendments if any/ BESCOM Specification. The type test reports shall not be older than Five (5) years.

I) Conductor:

a) Visual examination

b) Measurement of lay ratio/Direction of Lay.

c) DC resistance test on stranded conductor

d) Ultimate Tensile strength test on stranded conductor

e) Surface condition test on stranded conductor

II) Aluminium wires.

a) Measurement of Diameter

b) Breaking load test

c) Wrapping test,

d) DC Resistance Test

e) Procedure qualification test on welded joint of aluminium strands.

III) Steel Wires

a) Measurement of diameter

b) Breaking load Test

c) Ductility test,

d) Wrapping test,

e) Galvanizing test.

5.3 ACCEPTANCE AND ROUTINE TESTS:

I) Conductor:

a) Visual examination

b) Measurement of lay ratio/Direction of Lay.

II) Aluminium wires. (Test to be performed on Individual wire)

a) Measurement of Diameter

b) Breaking load test

c) Wrapping test,

d) DC Resistance Test

e) Procedure qualification test on welded joint of aluminium strands.

III) Steel Wires (Test to be performed on Individual wire)

a) Measurement of diameter

b) Breaking load Test

c) Ductility test,

d) Wrapping test,

e) Galvanizing test.

5.4 Selection of Sample of Test Sample for Routine Tests:

The Routine Tests shall be carried out on each Coil before stranding and test to be conducted as per Clause No.(13.1) of IS 398(Part-2):2025/Clause No. (5.3) of this specification

5.5 Selection of Sample of Test Sample for Acceptance tests

The For the purpose of acceptance test, samples of individual wires shall be taken by the manufacturer before stranding, from the outer ends of not less than 10 percent of wire coils and subjected to the acceptance tests specified in Clause No.(13.1) of IS 398(Part-2): 2025/ Clause No. (5.3) if desired by BESCOM.

The Coils/Lot offered for inspection, sample wire shall then be taken from length of stranded conductors. The 10 percent of random samples from lot the finished reels or drums offered for inspection shall be obtained by cutting 2 Mtrs from the outer ends of the finished conductor.

The raw material test report to be produced during acceptance test.

1	Chemical analysis of zinc used For making galvanising	Ref. Test Procedures
2	Chemical analysis of aluminium Used for making aluminium strands	- do -
3	Chemical analysis of steel used For making steel strands	- do -

5.6 TESTING EXPENSES:

5.6.1 The testing charges for the type tests specified shall be indicated separately in the prescribed schedule.

5.6.2 The Bidder shall indicate the type test charges for each type test separately. In case the same are not mentioned then the charges are deemed to have been included in the quoted rates of materials.

5.6.3 In case of failure in any type test, the Bidder is either required to modify the design of the material or repeat the particular type test three times successfully at his own expenses. The decision of the purchaser in this regard shall be final and binding. The type tests are to be conducted irrespective of whether the same have been conducted earlier or not.

5.6.4 Bidder shall indicate the laboratories in which he proposes to conduct the type tests. He shall ensure that the tests can be completed in these laboratories within the time schedule guaranteed by him in the appropriate schedule.

5.6.5 The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price of conductor, except for the expenses of the inspector/ purchaser's representative.

5.6.6 The prices quoted by the bidder towards conductance of type test shall be taken into consideration for bid evaluation.

5.7 ADDITIONAL TESTS:

The purchaser reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at supplier's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the specifications.

5.8 SAMPLE BATCH FOR TYPE TESTING:

5.8.1 The supplier shall offer at least three (3) drums for selection of samples required for conducting all the type tests.

5.8.2 The supplier is required to carry out all the acceptance tests successfully in the presence of purchaser's representative before dispatch.

5.9 TEST REPORTS:

5.9.1 Four copies of type test reports shall be furnished to the Purchaser within one month of conducting the tests. One copy will be returned duly certified by the purchaser to the supplier within three weeks thereafter and on receipt of the same supplier shall commence with the commercial production of the conductor.

5.9.2 Four copies of acceptance test reports shall be furnished to the purchaser. One copy will be returned, duly certified by the Purchaser and only thereafter shall the conductor be dispatched.

5.9.3 All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.

5.9.4 All test reports of tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when required for by the purchaser.

5.10 TEST FACILITIES:

5.10.1 The following additional test facilities shall be available at Supplier's works:

a) Calibration of various testing and measuring equipment including tensile testing machine resistance measurement facilities, burette, thermometer, barometer etc.

b) Standard resistance for calibration of resistance bridges.

c) Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc with transverse layering facilities.

6.0 INSPECTION:

6.1 The Purchaser's representative shall at all times be entitled to have access to the works and all places of manufacture where conductor shall be manufactured and the representative shall have full facilities for unrestricted inspection of the supplier's works raw materials and process of manufacture for conducting necessary tests as detailed herein.

6.2 The supplier shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.

6.3 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the purchaser in writing. In the later case also, the conductor shall be dispatched only after satisfactory testing for all tests specified herein has been completed.

6.4 The acceptance of any quantity of material shall in no way relieve the supplier of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.

6.5 At least 5% of the total number of drums subject to minimum of two in any lot put up for inspection, shall be selected at random to ascertain the length of conductor by following method:
"At the works of the manufacturer of the conductor, the conductor shall be transferred from one drum to another at the same time measuring its length with the help of a graduated pulley & Cyclometer. The difference in the average length thus obtained and as declared by the Supplier in the packing list shall be applied to all the drums if the conductor is found short during checking."

7.0 **QUALITY ASSURANCE PLAN**:

7.1 The Bidder shall invariably furnish following information along with his offer, failing which his offer shall be liable for rejection.

i. Statement giving list of important raw materials names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of Bidder's representative, copies of test certificates.
ii. Information and copies of test certificates as in (i) above in respect of bought out material.
iii. List of manufacturing facilities available.
iv. Level of automation achieved and list of areas where manual processing exists.
v. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
vi. List of testing equipments available with the Bidder for final testing of equipment specified and test plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviation from specified test requirements.

7.2 The supplier shall within 30 days of placement of order submit following information to the purchaser.

i. List of raw materials sub-suppliers selected from those furnished along with offer.
ii. Test certificates of the Raw material from OEM/NABL.
iii. Quality Assurance Plan (QAP) with hold points for Purchaser's inspection. The quality assurance plan and Purchaser's hold points shall be discussed between the Purchaser and supplier, before the QAP is finalized.

7.3 The supplier shall submit the routine test certificates of raw material at the time of routine testing on the conductor.

8.0 **PACKING & FORWARDING**:

8.1 The Conductor shall be supplied in non-returnable strong wooden drums provided with lagging of adequate strength, and displacement during transit, storage and subsequent handling and stringing operations in the field. The drums shall generally conform to IS: 1778-except otherwise specified hereinafter.

8.2 The drums shall be suitable for wheel mounting and for jetting off the conductor under a minimum controlled tension of the order of 5 KN.

8.3 The Bidder should submit the proposed drum drawings along with the bid. However, the same shall be in line with the requirements as stated herein. After placement of the Letter of Award, the supplier shall submit four copies of fully dimensioned drawing of the drum he wished to supply, for Purchaser's approval before taking up manufacturing of Conductor. After getting approval from the purchaser, supplier shall submit 30 more copies of the approved drawing to Purchaser for further distribution and field use at Purchaser's end.

8.4 All wooden components shall be manufactured out of seasoned softwood free from defects that may materially weaken the component parts of the drums. Preservative treatment for anti-termite/anti-fungus (Aldrime/Aldruse) shall be applied to the entire drum with preservatives of a quality, which is not harmful to the conductor.

8.5 The flanges shall be of two/three ply construction with each ply at right angles to the other and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. The tolerance in thickness of each ply shall be +3 mm only. There shall be at least 3 nails per plank of ply with maximum nail spacing of 75 mm. Where a slot is cut in the flange to receive the inner end of the conductor, the entrance shall be in the line with the periphery of the barrel.

8.6 The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.

8.7 Barrel studs shall be used for construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing. Barrel studs should be tack welded with the nuts after tightening.

8.8 Normally, the nuts on the studs shall stand protrude of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be countersunk. The ends of barrel shall generally be flushed with the top of the nuts.

8.9 The inner cheek of the flanges and drum barrel surface shall be painted with a bitumen-based paint.

8.10 Before reeling, cardboard or double corrugated or thick bituminized waterproof bamboo paper shall be secured to the drum barrel and inside of flanges or the drum by means of a suitable commercial adhesive material. The paper should be dried before use. Medium grade Kraft paper shall be used in between the layers of the conductor. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with thin polythene sheet across the flanges to preserve the conductor from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.

8.11 A minimum space of 125 mm shall be provided between the inner surface of the external protective layer and outer layer of the conductor.

8.12 Each batten shall be securely nailed across grains as far as possible to the flange edges with at least 2 nails per end. The length of the nails shall not be

less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp edges or allow the battens to be released due to corrosion.

8.13 Outside the protective layer, there shall be minimum of two binders consisting of hoop iron/galvanized steel wire. Each protective layer shall have two recesses to accommodate the binders.

8.14 The conductor ends shall be properly sealed and secured with the help of U-nails on one side of the flanges. The end securing shall be done by taking out at least 500 mm of steel core on either end by U-nails. The composite conductor shall be hinged by use of galvanized steel wire/ aluminium wire at three locations at least 75 mm apart or more covered with PVC adhesive tape so as to avoid loosening of conductor layers in transit and handling.

8.15 Only one length of conductor shall be wound on each drum.

8.16 **Marking**:

Each drum shall have the following information stenciled on it in indelible ink along with other essential data:

a) Contract/Award letter number.

b) Name and address of consignee.

c) Manufacturer's name and address.

d) Drum Number.

e) Size of conductor.

f) Length of conductor in meters.

g) Gross weight of drum with conductor.

h) Weight of empty drum with lagging.

i) Arrow marking for unwinding.

Sd/-

General Manager Ele

QS&S BESCOM

TEST PROCEDURES FOR THE APPLICABLE TESTS AS PER IS OR THIS SPECIFICATION

1.0 **Surface Condition Test**:

A sample of the finished conductor having a minimum recommended length of 5 meters with compression type dead end clamps compressed on both ends in such a manner as to permit the conductor to take its normal straight line shape, shall be subject to a tension of 50% of the UTS of the conductor. The surface shall not depart from its cylindrical shape nor shall the strands move relative to each other so as to get out of place or disturb the longitudinal smoothness of conductor. The measured diameter at any place shall be not less than the sum of the minimum specified diameters of the individual aluminium and steel strands.

2.0 **UTS Test on Stranded Conductor**:

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5-meter length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to specified 50% of UTS and held for one minute. The circles drawn shall not be distorted due to Relative movement of strands. Thereafter the load shall be increased at a steady rate to the minimum UTS specified in clause 3.1 (h) and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded.

3.0 **Corona Extinction Voltage Test**:

One sample of conductor of 5-meter length shall be strung. Incase of twin conductor, two samples shall be arranged with the actual sub-conductor spacing between them. This sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 176 kV (rms) for 220 kV system line to ground under dry condition. There shall be no evidence of corona on any part of sample when all possible sources of corona are photographed in a darkened room. The test shall be conducted without corona control rings. The voltage shall be corrected for standard atmospheric conditions.

4.0 **Radio Interference Voltage test**:

Under the conditions as specified in (2) above, the conductor samples shall have a radio interference voltage level below 1500 micro volts at one MHz when subjected to 50 Hz AC voltage of 1.1 times maximum line to ground voltage under dry condition. This test may be carried out with corona control rings and arcing horns.

5.0 **D.C. Resistance test on Stranded Conductor**:

On a conductor sample of minimum 5-meter length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0C as per Clause No.12.8 of IS: 398 (Part-V). The resistance corrected at 20^0C shall conform to the requirements of this specification.

6.0 **Stress-Strain Test**:

6.1 This test is contemplated only to collect the creep data of the conductor from the supplier. A sample of conductor of minimum 10-meters length shall be suitably compressed with dead end clamps.

6.2 Test set-up:

6.2.1 The test sample shall be supported in a trough over its full length and the trough adjustment so that the conductor will not be lifted by more than 10 mm under tension. This shall be ascertained by actual measurement.

6.2.2 The distance between the clamp and the sleeve mouth shall be monitored with calipers during the test to ensure that, after the test, it does not change by more than 1 mm $\pm$ 0.1 mm from the value before the test.

6.2.3 The conductor strain shall be evaluated from the measured displacements at the two ends of the gauge length of the sample. The gauge reference targets shall be attached to the clamps, which lock the steel and aluminium wires together. Target plates may be used with dial gauges or displacement transducers and care shall be taken to position the plates perpendicular to the conductor. Twisting the conductor, lifting it and moving it from side-to-side by the maximum amounts expected during the test should introduce no more than 0.3 mm error in the reading.

6.3 Test Loads for complete conductor.

The loading conditions for repeated stress-strain tests for complete conductor shall be as follows:

6.3.1 1-KN load shall be applied initially to straighten the conductor. The load shall be removed after straightening and then the strain gauges are to be set at zero at zero tension.

6.3.2 For non-continuous stress-strain data, the strain readings at 1 KN intervals at lower tensions and 5 KN intervals above 30% of UTS shall be recorded.

6.3.3 The sample shall be reloaded to 50% of UTS and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes during the hold period. The load shall be released after the hold period.

6.3.4 Reloading up to 70% of UTS shall be done and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes. The load shall then be released.

6.3.5 Reloading up to 85% of UTS shall be done and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes and then the load shall then be released.

6.3.6 Tension shall be applied again and shall be increased uniformly until the actual breaking strength is reached. Simultaneous readings of tension and elongation shall be recorded up to 90% of UTS at the intervals described under Clause 6.3.5.

6.4 **Test Loads for Steel Core only**:

The loading conditions for repeated stress-strain tests for the steel core of ACSR shall be as follows:

6.4.1 The test shall consist of successive application of load applied in a manner similar to that for the complete conductor at 30%, 50%, 70% and 85% of UTS.

6.4.2 The steel core shall be loaded until the elongation at the beginning of each hold period corresponds to that obtained on the complete conductor at 30%, 50%, 70% and 85% of UTS respectively.

6.5 **Stress Strain Curves**:

The design stress-strain curve shall be obtained by drawing a smooth curve through the 0.5 and 1-hour points at 30%, 50% and 70% of UTS loadings. The presence of any aluminium slack that can be related to any observed extrusion entering the span from the compression dead ends shall be removed from the lower ends of the design curves. Both the laboratory and design stress-strain curves shall be submitted to the Purchaser along with test results. The stress-strain data obtained during the test shall be corrected to the standard temperature i.e. 20^0C.

7.0 **Chemical Analysis of Zinc**:

Samples taken from the zinc ingots shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

8.0 **Chemical Analysis of Aluminium and Steel**:

Samples taken from the Aluminium ingots/coils/strands shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

9.0 **Visual and Dimensional Check on drums**.

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this specification.

10.0 **Visual Check for Joints, Scratches etc**:

Conductor drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc and that the conductor generally conforms to the requirements of this specification.

11.0 **Dimensional check of steel and aluminium strands**:

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

12.0 **Check for Lay-ratios of various Layers**:

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this specification and clause No.9.4 & 9.5 of IS-398 (Part-V).

13.0 **Galvanizing Test**:

The test procedure shall be as specified in IS: 4826. The material shall conform to the requirement of this specification.

14.0 **Torsion and Elongation Tests on Steel Strands**.

The test procedures shall be as per clause No.12.6.1 and 12.6 of IS:398 (Part-V). In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twist will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 200 mm.

15.0 **Breaking load test on welded Aluminium strand**:

Two Aluminium Wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The welded point of the wire shall be able to withstand the minimum-breaking load of the individual strand guaranteed by the supplier.

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GUARANTEED TECHNICAL PARTICULARS OF CONDUCTORS

Sl.No.	Particulars	COYOTE ACSR
1.	Code Word	
2.	Manufacturer's Name & Address	
	a. Aluminium wires	
	b. Complete Conductor	
3.	Stranding and Wire Diameter: a. Aluminium b. Steel	
4.	Nominal Aluminium Area in Sq.mm	
5.	Sectional Area of Aluminium Strands in Sq.mm	
6.	Total Sectional Area in Sq.mm	
7.	Cross sectional area of Nominal diameter wire in sq.mm a. Aluminium Wire b. Steel wire	
8.	Overall Diameter of conductor in mm	
9.	Breaking load of conductor in KN	
10.	Minimum breaking load in KN for a. Aluminium Wire b. Steel wire	
11.	Zinc coating of steel wire a. Uniformity of coating, No. & duration of dips (process test with stood 1 Min x nos.) b. Minimum weight of coating (gr/ sq.mm)	
12.	Mass in kg. per KM a. Aluminium b. Steel c. Conductor	
13.	Resistance in ohm per KM at 20 Deg.C.	
14.	a. Continuous maximum current rating of conductor (Amps) in still air or 45 Deg. C. ambient temperature b. Temperature rise for the above current Deg. C.	

15.	Purity of Aluminium Rods	
16.	Maximum working tension for complete conductor Kg.	
17.	Modulus of Elasticity (Kg/mm^2) - a. Aluminium b. Steel c. Conductor	
18.	Co-efficient of linear expansion per Degree a. Aluminium Wire b. Steel Wire c. Conductor	
19.	Standard length of each piece in/ KM	
20.	Tolerance, if any, on standard length	
21.	No. of standard lengths in one reel	
22.	Approximate dimensions of the reel in Cms	
23.	Mass of conductors in one reel in Kgs	
24.	Gr. Mass of the reel including mass of the conductor	
25.	Mass of the reel in Kgs	
26.	Standard according to which the conductor will be manufactured & tested	
27.	Date of commencement of Production of Conductor	

Seal and signature of the Supplier